EMERGENCY STRUCTURAL ASSESSMENT

OF

EARTHQUAKE DAMAGE TO

NORTH KAWAIHAE SMALL BOAT HARBOR

LOCATED AT

KAWAIHAE, HAWAII

PREPARED FOR

THE STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

DIVISION OF BOATING AND OCEAN RECREATION

HONOLULU, HAWAII 96813

THIS WORK WAS PREPARED BY ME
OR UNDER MY SUPERVISION.

SIGNATURE

PREPARED BY

ARNOLD T. OKUBO & ASSOCIATES, INC.
94-529 UKEE STREET, SUITE 107
WAIPAHU, HAWAII 96797

NOVEMBER 2006

TABLE OF CONTENTS

I. INTRODUCTION

II. SUMMARY

III. SCOPE OF WORK

IV. SITE DESCRIPTION OF NORTH KAWAIHAE SMALL BOAT HARBOR

V. AREA AND METHOD OF INVESTIGATION

VI. OBSERVATION AND FINDINGS OF FIELD INVESTIGATION

VII. ORDER OF MAGNITUDE ESTIMATED DESIGN AND CONSTRUCTION COST ESTIMATE TO REPAIR EARTHQUAKE DAMAGES TO NORTH KAWAIHAE SMALL BOAT HARBOR STRUCTURES

VIII. CONCLUSION AND RECOMMENDATIONS

I. INTRODUCTION

The purpose of this report is to conduct a structural assessment of the earthquake damages to the boating facility at North Kawaihae Small Boat Harbor. The earthquake occurred on October 15, 2006 and had a magnitude of 6.7.

II. SUMMARY

Underwater and Above Water Inspection/Assessment:

A. The Marginal Wharf 10"ø Steel Pipe Piles - Fair condition.

B. Loading Docks No. 1 & No. 2 Concrete Piles - Fair condition.

C. Rock Mound/Revetment Seawall located at East Side along Marginal Wharf - Many sections of loose and displaced rocks that need to be repaired/reconstructed.

D. Rock Mound/Revetment Seawall located at North Side along Access Road - Some sections of loose and displaced rocks need to be repaired/reconstructed.

E. Boat Launching Ramp - Slab has many cracks and needs to be reconstructed.

F. Loading Dock No. 2 - Approach walkway ramp and wall need to be reconstructed.

The order of magnitude estimated design and construction cost estimate to repair earthquake damages are $ 1,850,000.00.

III. SCOPE OF WORK

The work involves the following:

1. Conduct an above water investigation/inspection by a licensed structural engineer to determine and assess the structural damages on the North Kawaihae Small Boat Harbor Boating Facilities caused by the recent earthquake on October 15, 2006. These facilities include the marginal wharf, boat launching ramp, loading docks No. 1 & No. 2, and the rock mound/revetment seawall.

2. Conduct an underwater investigation/inspection by a licensed structural engineer to determine and assess the structural damages caused by the recent earthquake to the piles of the marginal wharf, and the piles of loading docks No. 1 & No. 2. Also, to inspect the rock mound/revetment seawall.

3. Provide a report on the findings.

4. Make recommendations to repair the earthquake damages.

5. Provide a 0% design order of magnitude estimated design and construction cost estimate to repair earthquake damages.

IV. SITE DESCRIPTION OF NORTH KAWAIHAE SMALL BOAT HARBOR

1. Description:

The North Kawaihae Boating Facility consists of a marginal wharf, boat launching ramp, and loading dock No. 1 and loading dock No. 2. The small boat harbor shoreline is protected by a rock revetment seawall.

The Marginal Wharf was reconstructed in 1982. The deck is 15'-0" wide by 200'-0" long. The deck is constructed of wood decking supported on wood beams. The outboard beams are supported on 10" diameter steel pipe piles. The piles are filled with concrete/grout. The inboard beams are supported on concrete caps resting on the rock revetment seawall.

The shoreline is protected by a continuous rock mound/revetment seawall. The rock mound/revetment seawall is constructed of 400 lb. - 2500 lb. boulders and some portions of the revetment surfaces are cement grouted.

The Boat Launching Ramp is constructed of concrete slab on grade. Portion of the ramp that is below the high tide elevation is constructed of pre-cast concrete slab. The area at the top of the boat ramp is cast-in-place concrete slab on grade.

Loading Dock No. 1 adjacent to the Boat Launching Ramp is approximately 30'-0" long. The deck is of wood construction supported on concrete pile caps and concrete piles.

Loading Dock No. 2 is approximately 3'-0" wide by 35'-0" long. The deck is constructed of pre-cast concrete double tee and supported on concrete pile caps and concrete piles.

2. Function of the Facility:

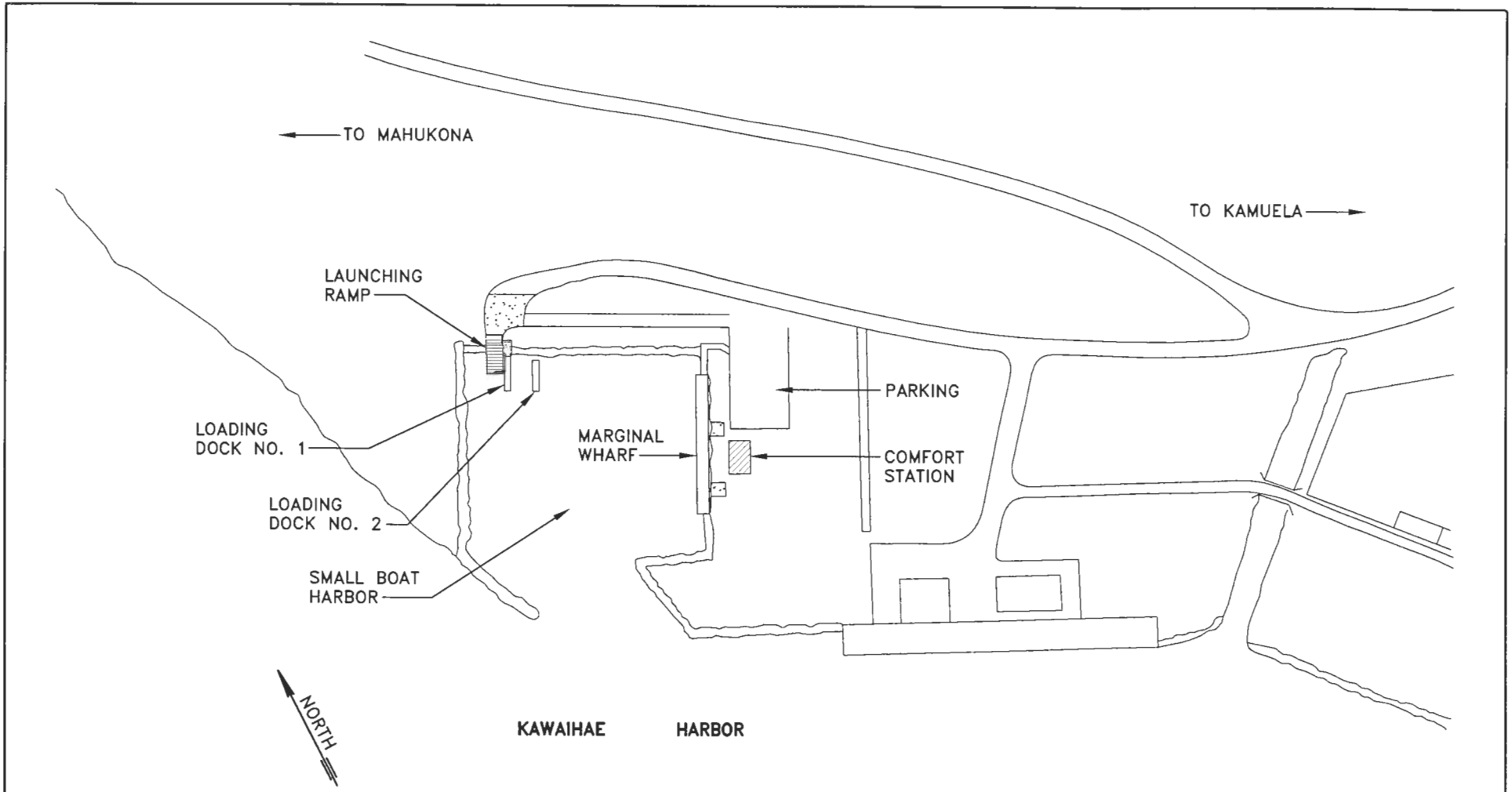
The wharf is primarily used to load and off load passengers of small vessels.

1 North Kawaihae Small Boat Harbor - Marginal Wharf (Looking East)

2 North Kawaihae Small Boat Harbor - Boat Ramp, Loading Dock No. 1 and No. 2, North Side Seawall, and Marginal Wharf (Looking North)

EXISTING NORTH KAWAIHAE SMALL BOAT HARBOR

PLANS AND SECTIONS



HARBOR PLAN

NOT TO SCALE

KAWAIHAE HARBOR

EMERGENCY STRUCTURAL ASSESSMENT OF EARTHQUAKE DAMAGE THAT OCCURED ON OCT. 15, 2006

HARBOR PLAN

DATE: 11/06/06	DWG. NO. S-1

V. AREA AND METHOD OF INVESTIGATION

1. Underwater Investigation:

An underwater inspection of the piles for the marginal wharf, loading dock No. 1, loading dock No. 2, and the rock mound/revetment seawall was conducted on October 24, 2006. A careful examination of the structures by a licensed structural engineer/diver is essential for an accurate structural assessment of the damage and deterioration so that a realistic evaluation can be made. SCUBA equipped licensed structural engineer/diver was used for the inspection. Piles were visually inspected from the waterline down to the mudline for deterioration and failure.

A SCUBA equipped licensed structural engineer/diver inspected and evaluated the structures underwater. Also, one (1) licensed civil engineer/diver assisted the structural engineer during the underwater inspection.

No underwater photos were taken due to the poor visibility conditions.

2. Above water Investigation:

An above water inspection of North Kawaihae Small Boat Harbor Facility was conducted on October 24, 2006. The structures were inspected for visual symptoms of deterioration consisting of cracking, spalling, settlement, and surface disintegration caused by the October 15, 2006 earthquake. The structures inspected were the marginal wharf, boat launching ramp, and loading dock No. 1, loading dock No. 2, and rock mound/revetment seawall.

VI. OBSERVATION AND FINDINGS OF FIELD INVESTIGATION

1. Underwater Investigation:

   A. Piles:

   Marginal Wharf: The 10" diameter steel pipe piles are in fair condition.

   Loading Dock No. 1: The concrete piles are in fair condition.

   Loading dock No. 2: The concrete piles are in fair condition.

   B. Rock Mound/Revetment Seawall:

   Along the marginal wharf some loose revetment rocks were observed below the waterline at various locations.

   Along the north side (next to the roadway) some loose revetment rocks were observed below the waterline at various locations.

2. Above water Investigation:

   A. Marginal Wharf:

   There were some movement of the wooden deck concrete support caps at the landside adjacent to the rock mound/revetment seawall. The wooden deck structure was already not in use due to a previous wave damage. The writer had previously inspected the wooden marginal wharf deck on March 2, 2006 and the wooden wharf deck structural condition in the writer's opinion has not change due to the earthquake.

   The landside concrete slab walkway have cracks caused by the earthquake.

   The landside area along the wharf has moved a few inches and created a longitudinal crack in the ground.

   The rock mound/revetment seawall has shifted outward along the length and parallel to the marginal wharf. Visible cracks, separations and settlements, can be seen on the ground and revetment seawall surfaces.

   B. Rock Mound/Revetment Seawall:

   The rock mound/revetment seawall has some loose revetment rocks at various locations along the length of the marginal wharf.

C. Boat Launching Ramp:

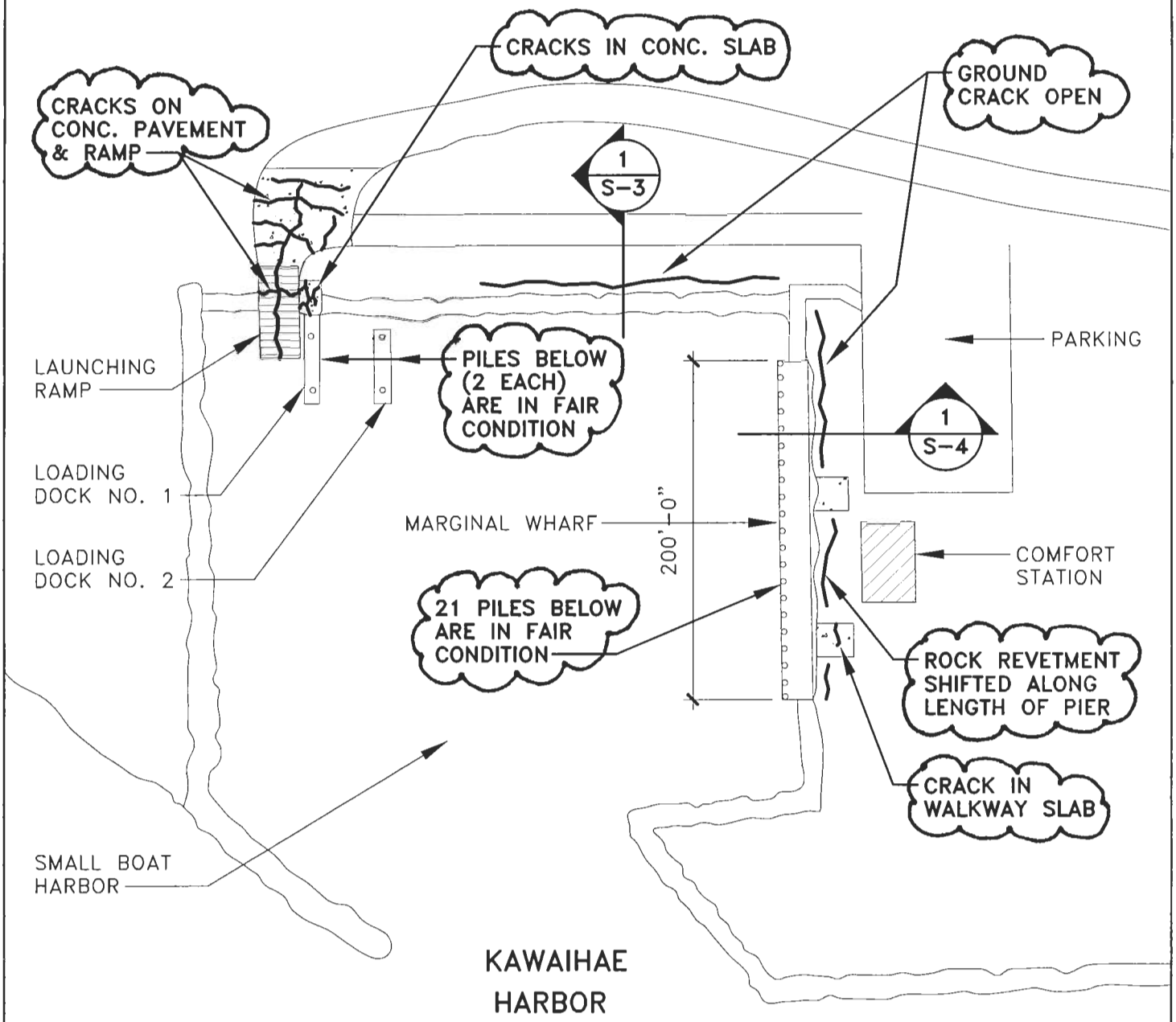
There are numerous significant large cracks throughout the boat launching ramp concrete slab, approach slab, and pavement slab.

D. Loading Dock No. 1 (Adjacent to the Boat Launching Ramp):

Concrete slab walkway and wall have significant cracks.

E. Loading Dock No. 2:

Loading Dock No. 2 was previously damaged before the earthquake. There is no approach ramp to the dock and the dock is not being used.



EXISTING CONDITION – HARBOR PLAN

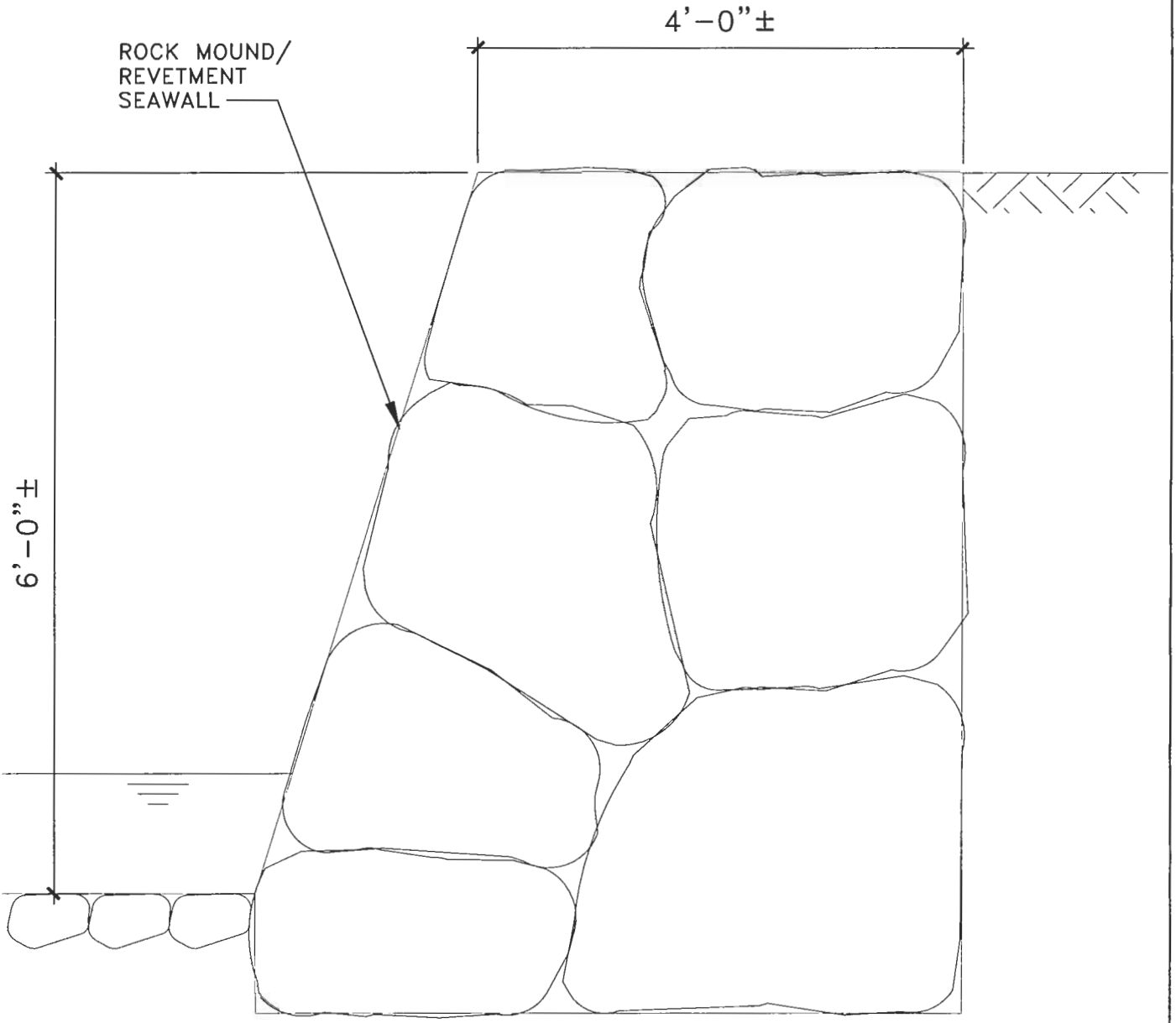
NOT TO SCALE

KAWAIHAE HARBOR

EMERGENCY STRUCTURAL ASSESSMENT OF EARTHQUAKE DAMAGE THAT OCCURED ON OCT. 15, 2006

EXISTING CONDITION – HARBOR PLAN

DATE: 11/06/06	DWG. NO. S-2



NORTH SIDE – ROCK MOUND/REVETMENT SEAWALL

1/S-3 TYPICAL SECTION

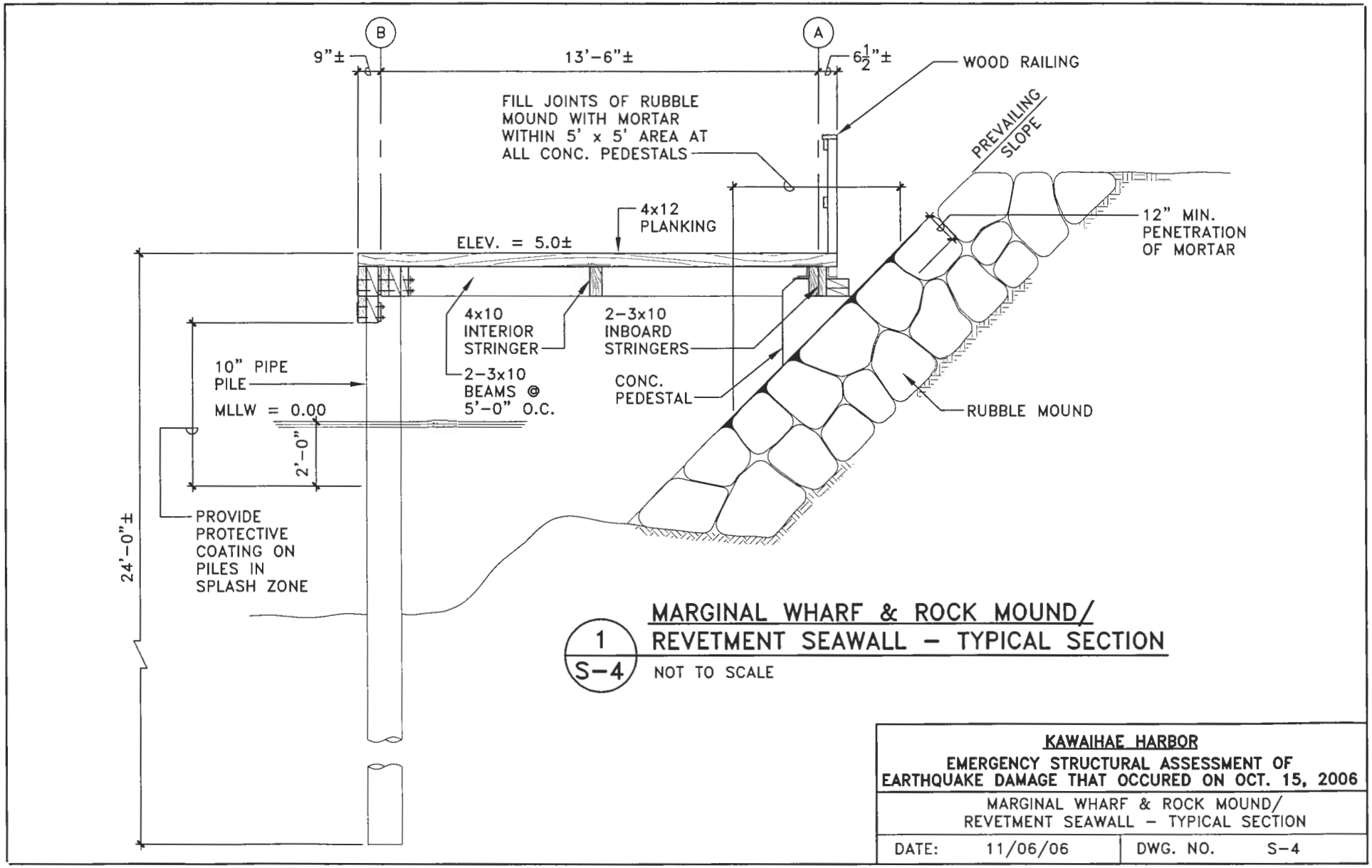
SCALE: 3/4" = 1'-0"

KAWAIHAE HARBOR

EMERGENCY STRUCTURAL ASSESSMENT OF EARTHQUAKE DAMAGE THAT OCCURED ON OCT. 15, 2006

NORTH SIDE – ROCK MOUND/REVETMENT SEAWALL – TYPICAL SECTION

DATE: 11/06/06	DWG. NO. S-3



MARGINAL WHARF & ROCK MOUND/ REVETMENT SEAWALL – TYPICAL SECTION

1/S-4

NOT TO SCALE

KAWAIHAE HARBOR

EMERGENCY STRUCTURAL ASSESSMENT OF EARTHQUAKE DAMAGE THAT OCCURED ON OCT. 15, 2006

MARGINAL WHARF & ROCK MOUND/ REVETMENT SEAWALL – TYPICAL SECTION

DATE: 11/06/06	DWG. NO. S-4

PHOTOGRAPHS

ABOVE WATER CONDITION OF

MARGINAL WHARF,

ROCK MOUND/REVETMENT SEAWALL,

BOAT LAUNCHING RAMP,

LOADING DOCK NO. 1,

AND

LOADING DOCK NO. 2

3 North Revetment Wall - Ground movement and settlement

4 Area Behind North Revetment Wall - Ground movement and settlement

5 Marginal Wharf Approach Walkway
(Looking East)

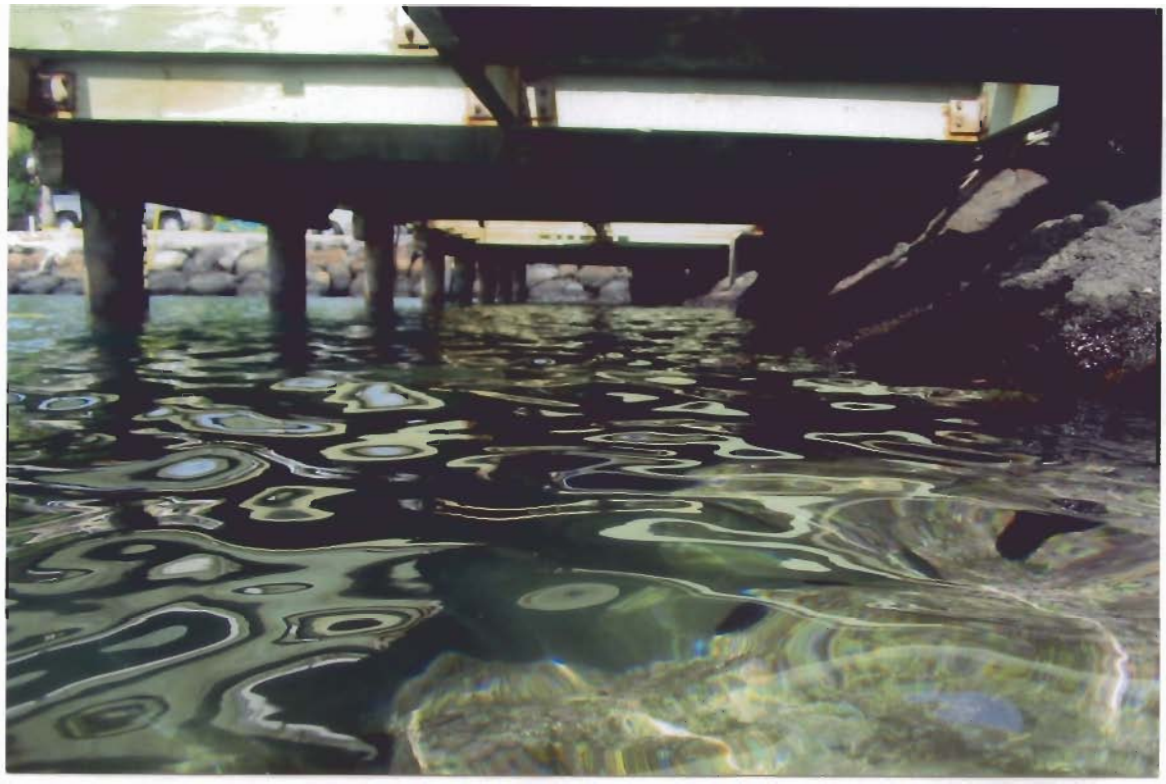
6 Marginal Wharf - Cracks at
rock revetment seawall

7 Marginal Wharf - (Looking South East)

8 Marginal Wharf - (Looking South East)

9 Marginal Wharf - (Looking North)

10 Marginal Wharf - (Looking South)

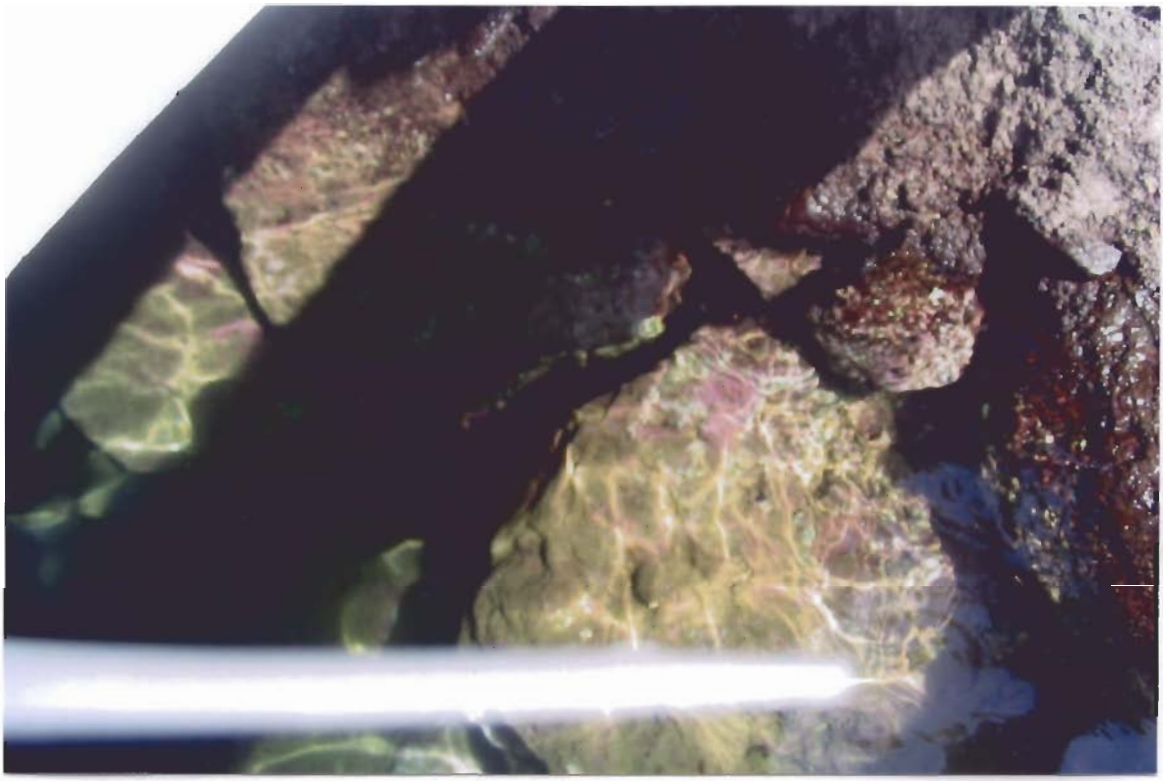


11 Underside of Marginal Wharf -
(Looking North)

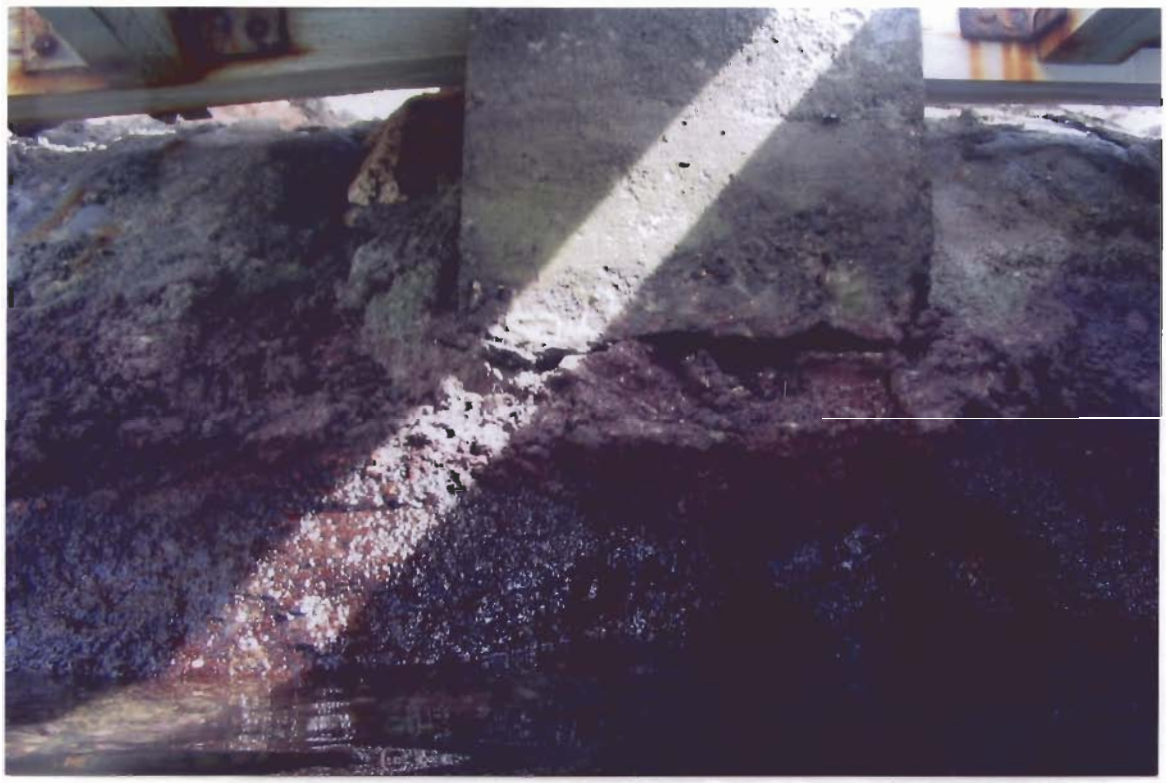
12 Typical 10 inch diameter steel pipe pile
(Looking North)

13 Underside of Marginal Wharf
(Looking South)

14 Underside of Marginal Wharf
(Looking North)



15 Rock revetment seawall separated at toe of wall



16 Concrete support pedestal for deck separated from rock revetment seawall

17 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking South)

18 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking North)

19 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking North)

20 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking North)

21 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking North)

22 Movement and separation of rock revetment seawall along East Side of Marginal Wharf - (Looking North)

23 Crack and movement of rock revetment seawall and crack slab

24 Crack landing slab at stairway to Marginal Wharf

25 North Side - Cracks at Boat Launching Ramp approach ramp concrete slab

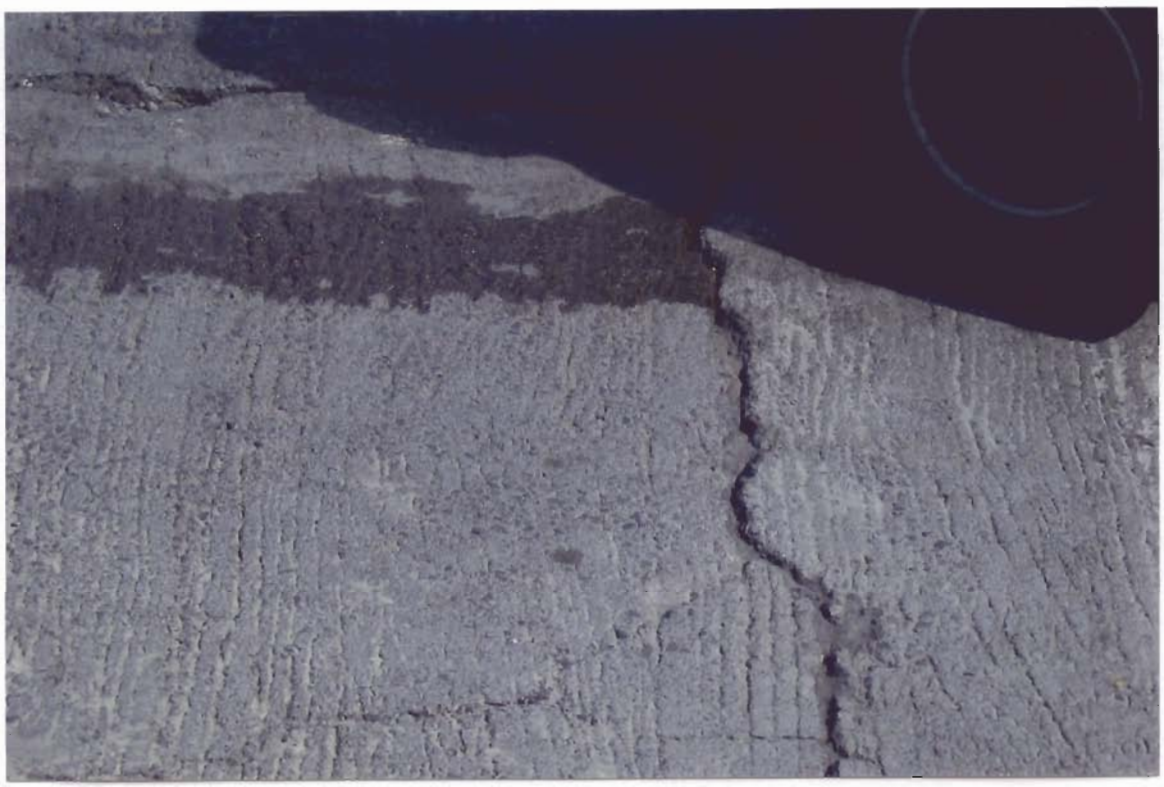
26 Cracks at Boat Launching Ramp approach concrete slab

27 Cracks on Boat Ramp Concrete Slab

28 Failed Concrete Pile Curb at Boat Ramp

29 Cracks at Boat Ramp Slab

30 Cracks at Boat Ramp Slab



31 Close-up view of cracks at Boat Ramp Slab

32 Cracks at Boat Ramp Slab

33 Cracks at Boat Ramp Slab

34 Cracks at Boat Ramp Slab

35

Cracks at Boat Ramp Slab

36 Cracks at Boat Ramp Concrete Pavement Slab

37

Cracks at Boat Ramp Concrete Pavement Slab

38 Loading Dock No. 1 - Cracks at Concrete Approach Walkway Slab

39 Loading Dock No. 1 - Cracks at Concrete Approach Walkway Slab

40 Loading Dock No. 1 @ Boat Launching Ramp

41 Loading Dock No. 1 @ Boat Launching Ramp

42 Loading Dock No. 2 -
No approach walkway to dock

43 Loading Dock No. 2

VII. ORDER OF MAGNITUDE ESTIMATED DESIGN AND CONSTRUCTION COST ESTIMATE TO REPAIR EARTHQUAKE DAMAGES TO NORTH KAWAIHAE SMALL BOAT HARBOR STRUCTURES

ORDER OF MAGNITUDE ESTIMATED DESIGN AND CONSTRUCTION COST ESTIMATE

Submitted By: Arnold T. Okubo and Associates, Inc. Date: 11/03/06
Project: North Kawaihae Small Boat Harbor
Kawaihae, Hawaii Sheet 1 of 1

Emergency Structural Assessment of Earthquake Damage to North Kawaihae Small Boat Harbor

	Item Description	Quantity Number	Unit	Estimated Construction Cost Unit Cost	Total
1)	Mobilization & Demobilization	Job	L.S.	L.S.	$ 100,000
2)	Repair Marginal Wharf Conc. Stairway Landing	2	EA.	L.S.	10,000
3)	Repair Boat Launching Ramp and Conc. Slab Pavement	Job	L.S.	L.S.	300,000
4)	Repair / Reconstruct Rock Mound / Revetment Seawall Along East Side Next to Marginal Wharf	400	C.Y.	1,000	400,000
5)	Repair to Loading Dock No. 1	Job	L.S.	L.S.	100,000
6)	Repair / Reconstruct Rock Mound / Revetment Seawall Along North Side Next to Access Road	360	C.Y.	1,000	360,000
				Sub-Total	$ 1,270,000
				20% Contingencies	254,000
				Order of Magnitude Estimated Design and Construction Cost Estimate @ 0% Design	$ 1,524,000
				Design, Permiting, Survey, Etc.	240,000
				Construction Adminstration	80,000
				Total Estimated Construction Cost	**$ 1,844,000**
				SAY	**$ 1,850,000**

VIII. CONCLUSION AND RECOMMENDATIONS

Rock Mound/Revetment Seawall:

The rock revetment seawall along the marginal wharf has significant displacement and movement caused by the earthquake. The rock revetment seawall should be reconstructed to protect the landside from erosion and sliding.

Boat Launching Ramp:

The boat launching ramp has significant cracks and should be reconstructed. The approach slab and pavement also has large cracks throughout and should be reconstructed.

Loading Dock No. 1:

The loading dock No. 1 walkway slab and wall are cracked and should be reconstructed.

Marginal Wharf:

The concrete stairway landings are cracked and should be reconstructed.